

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Tracheostomy

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Tracheal Anatomy

The trachea begins at the **lower edge of the cricoid** cartilage and extends to the level of the carina.

It consists of **18 to 22 anterior C-shaped** tracheal rings lined by a posterior membranous wall.

It starts anterior and midline in the neck below the cricoid cartilage and then it dives posterior in the mediastinum.

The esophagus starts at the same level and lies at the left posterior border of the trachea.

The **thyroid gland** is found anterior and lateral to the proximal trachea with the isthmus projecting apically at the level of **the second or third tracheal ring**.

The structure associated with this procedure's deadliest complications is the **innominate artery**. It crosses the anterior aspect of the trachea in an oblique fashion inferior to **the third or fourth tracheal ring**.

Timing

The advantages of tracheostomy in the setting of prolonged mechanical ventilation are well established. However, the timing of replacing a temporary artificial airway (ETT) with a tracheostomy has been controversial¹⁴ because of two main challenges.

One is the inability of clinicians to predict the need for prolonged mechanical ventilation accurately within several days of initiation.

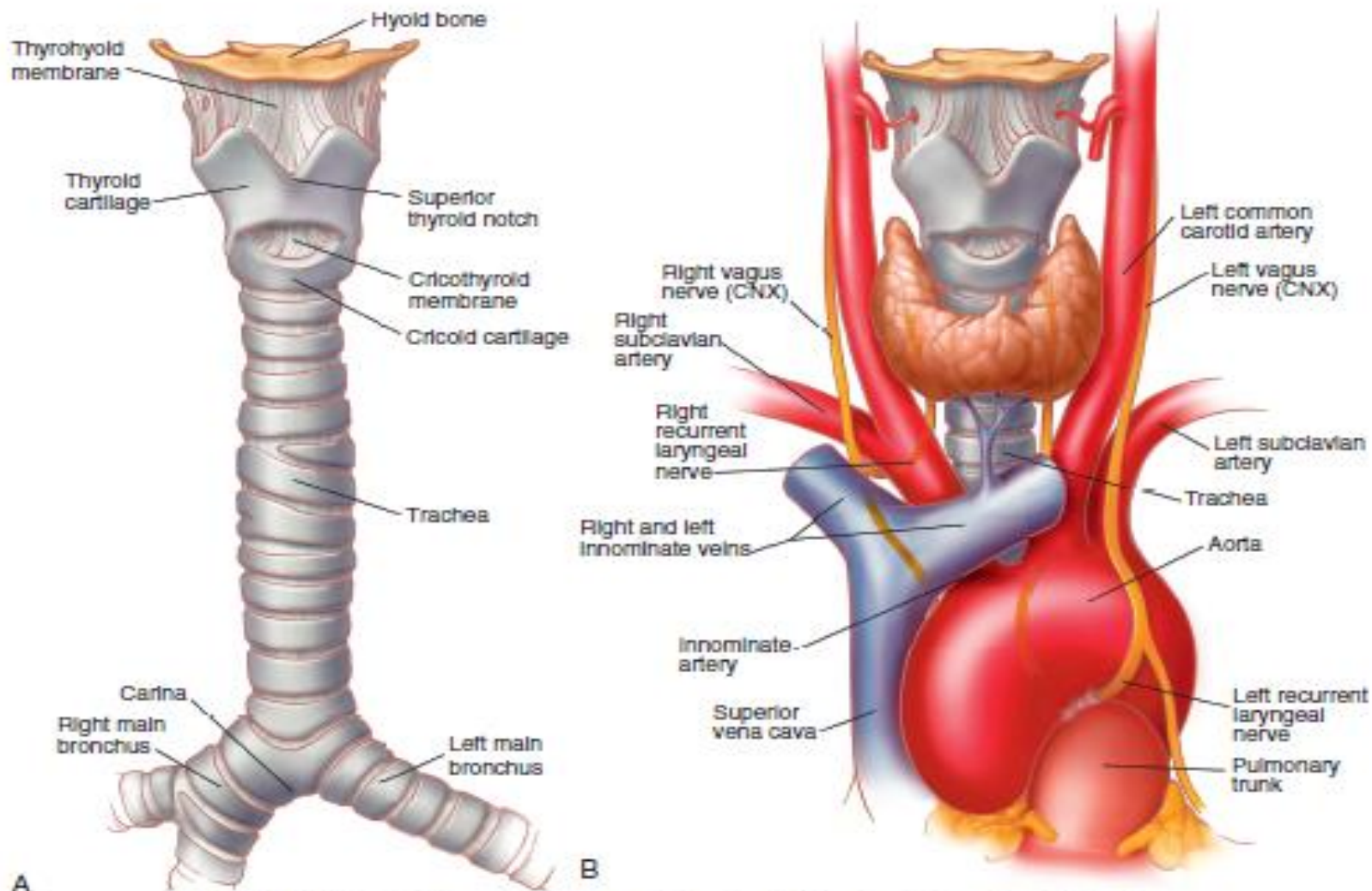
There is also ongoing debate regarding early versus late tracheostomy. Early timing has been generally defined as within 3 to 10 days,



The most positive study on early tracheostomy was a prospective randomized trial involving several centers by Rumbak et al.²¹ In this study, early tracheostomy was associated with significantly lower mortality, nosocomial pneumonia rate, and shorter duration of ICU stay and mechanical ventilation.

Several other studies have demonstrated no difference in mortality but decreased duration of mechanical ventilation.^{22,23} Systematic reviews and meta-analysis of randomized trials have also shown no difference in rates of mortality^{24,25} but were variable relative to mechanical ventilation duration and ICU length of stay.

Patients with **severe head trauma** often require tracheostomy for airway protection because of poor cough and clearance of secretions, rather than the need for mechanical ventilation



• **Fig. 14.1** A, Principal features of the larynx and trachea. Anterior view. Tracheobronchial angles vary widely. (B) Relationships of trachea to surrounding structures. Anterior view. CNX, Cranial nerve X. (From Minnich DJ, Mathisen DJ. Anatomy of the trachea, carina, and bronchi. *Thorac Surg Clin*. 2007 17:571–578.)

• **BOX 14.3** Steps for Percutaneous Dilatational Tracheostomy

1. Hold tube feeding at least 4–6 hours prior to procedure
2. Hold anticoagulation appropriately to agent used
3. Keep patient on 100% FiO₂
4. Properly position the patient with maximum neck extension
5. Ensure adequate sedation and paralysis of the patient
6. Place bite block to avoid injury to teeth or bronchoscope
7. Deflate the ET cuff and withdraw ET under laryngoscopic vision until cuff is visualized just below cords, then reinflate the cuff
8. Clean, drape the patient as per protocol
9. Identify the site of insertion
10. Infiltrate the skin with local anesthetic containing a vasoconstrictor
11. Make a 2–2.5 cm transverse incision at the proposed insertion site
12. Advance a sheathed introducer needle into trachea stabilizing the trachea during the process
13. Tracheal placement of needle is confirmed by aspirating air bubbles into the saline solution-filled syringe attached to the needle, and by direct visualization through the bronchoscope
14. Withdraw the needle and insert Seldinger guidewire through the plastic sheath which is withdrawn out
15. Dilate the insertion site with the help of a small tracheal dilator
16. Single graduated dilator is moisturized with saline and then loaded over the guiding catheter
17. The whole assembly is then loaded over the guidewire and advanced as a unit into trachea in a sweeping action
18. After adequate dilatation, dilator is removed and tracheostomy tube with appropriate adapter is inserted into trachea over the guiding catheter
19. Placement of tracheostomy tube is confirmed by direct visualization of carina through the bronchoscope or by EtCO₂ graph
20. Connect tracheostomy tube to ventilator and ensure volume return
21. Suture tracheostomy to the skin and secure using a trach tie

ET, Endotracheal tube; EtCO₂, end-tidal carbon dioxide; FiO₂, fraction of inspired oxygen.

Organization of Care and Safety During Bedside Tracheostomy

Tracheostomy is one of the **most hazardous procedures** performed in the ICU. Although intraprocedural **complications are rare**, vascular injury resulting in hemorrhage, loss of airway control, or airway injury is catastrophic and may rapidly result in death, with rates as high as 75%^{27,28} for loss of airway control. It is prudent to take appropriate precautions to avoid these problems or manage them when they arise.



The first step is appropriate **patient selection**. There are few absolute contraindications and a small number of relative contraindications (described elsewhere in this chapter).

The development of a team approach and a **safety checklist** for bedside tracheostomy has been demonstrated to decrease complications.

This should include a well-trained lead **physician and assistant**; an **airway management practitioner** who is capable of reintubation if necessary and will manage the ventilator; a **nurse** or other provider to administer sedation and pain medication and monitor the patient's clinical status; and a circulator who can run for supplies.

If bronchoscopic support is planned, a skilled bronchoscopist should be included. Some practitioners consider that such bronchoscopic assistance is required for PDT, but the literature does not support improved complication rates.

The bronchoscope should be available immediately for emergencies, even if not used routinely.

Ultrasound has also been used as an adjunct to **avoid vascular injury** but it has not yet been demonstrated to be of benefit in this setting.

If the primary proceduralist is not a surgeon, it is appropriate to have **surgical “backup”** in the hospital. It is therefore wise to plan elective bedside tracheostomy during daytime hours to ensure the availability of maximum personnel support in an emergency.



The **equipment for the procedure** should be in the room before starting, as well as any equipment that may be needed to deal with unplanned events. An assortment of **tracheostomy tube sizes** should be available as well as endotracheal tubes and laryngoscopes for reintubation.

If PDT is planned, a **surgical tracheostomy** tray should be in the unit, as well as equipment for cricothyrotomy should the need arise. **Good lighting** is essential and headlamps may be of benefit.

The team should prepare for bedside percutaneous or surgical tracheostomy as they would for any operation. This includes discussion of the plan for sedation, the procedure itself, the roles of the team members, and any particular concerns regarding the individual patient.

Structuring this practice with the use of a World Health Organization style checklist has been demonstrated to reduce complication rates significantly for bedside tracheostomy



Techniques

Percutaneous (Box 14.3)

PDT, also known bedside tracheostomy, is the placement of a tracheostomy tube. This technique **uses a small skin incision and dilation of the subcutaneous tissue** into the tracheal lumen without direct surgical visualization of the trachea.

It is considered **minimally invasive** and is often done at the **bedside in the ICU, avoiding the risks of transporting** a critically ill patient and the **costs of the operating room**. PDT is done with continuous monitoring of the patient's vital signs and often is performed under direct bronchoscopic visualization



The most common technique used is the Ciaglia technique (Video 14-1). With this technique, there is no sharp dissection involved beyond the skin incision. The patient is positioned and prepared in the same way as for the standard operative tracheostomy. **Deep sedation** is administered and all steps are done under **bronchoscopic** vision. The **endotracheal tube** is withdrawn under bronchoscopic guidance about 1 to 2 cm below the vocal cords to expose the space below the first tracheal ring by using digital pressure at 2 cm above the sternal notch while looking at the bronchoscopic view. The incision site is selected to correspond to the space between the **second and third tracheal rings**. **Lidocaine 2% with epinephrine** is used for local anesthesia and then a 2-cm incision is made. The pretracheal tissue is then cleared with blunt dissection. The operator **enters the tracheal lumen below the second tracheal ring** with an introducer needle through the incision (Fig. 14.2). The tract between the skin and the tracheal lumen is then serially dilated over a **guidewire and stylet**. A tracheostomy tube is placed under direct **bronchoscopic vision over a dilator**. Placement of the tube is also confirmed by visualizing the tracheobronchial tree through the



tracheostomy. The tracheostomy tube is then **secured to the skin** with sutures and a tie or device encircling the neck.

Although there is a learning curve to the technique, there are several advantages of PDT. **The time required for bedside PDT is considerably shorter than that for an open tracheostomy.**

The **elimination of operating room scheduling issues and costs**, as well as the **risks of transport**, provide benefit to the patient and critical care team. In fact, the cost of performing PDT at the bedside is roughly half that of performing open surgical tracheostomy in the operating room.³⁵



• **Fig. 14.2** A, Insertion of a 15-gauge needle into the trachea. B, The guidewire is inserted through the needle into the trachea. (From Friedman Y, Franklin C. The technique of percutaneous tracheostomy. Using serial dilation to secure an airway with minimal risk. *J Crit Illn.* 1993;8:289-297. Copyright Margulies Medical Art, Miami, FL.)